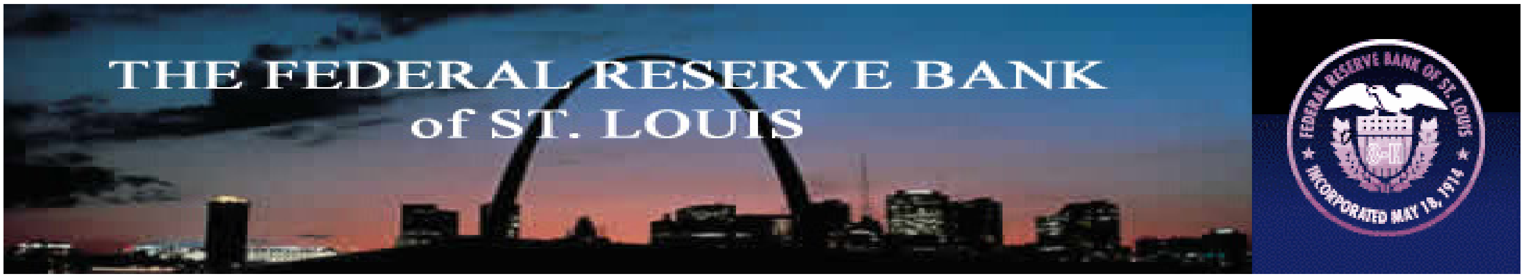

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INVESTIGATING WEEKLY SURVEY
FORECASTS OF THE FEDERAL FUNDS RATE

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Investigating Weekly Survey Forecasts of the Federal Funds Rate

by R. W. HAFER

1. INTRODUCTION

The existence of several survey measures of economic forecasts have made it possible for researchers to test directly the economic characteristics and relative accuracy of such expectations. Because market expectations are unobservable, survey measures provide a close substitute with which alternative hypotheses may be tested.[1/] For example, a large number of studies have investigated the properties of the Livingston price expectations series (see, inter alia, Carlson [3], Pesando [14], Mullineaux [12], and Jacobs and Jones [11]). Another expectations series receiving attention is that generated from the American Statistical Association-National Bureau of Economic Research's (ASA-NBER) quarterly survey of professional forecasters (see, for example, Zarnowitz [17] and Hafer and Hein [9]). A great deal of effort also has been directed recently to studying the formation and interest rate effects of weekly money supply forecasts compiled by Money Market Services, Inc. (see Grossman [7], Roley [15], Urich and Wachtel [16], and Hafer [8].

Although much research has been done on survey expectations of macroeconomic variables, little work has appeared dealing with interest rate expectations . Although Friedman [5] is a notable exception, such studies have not appeared primarily due to a lack of data. Instead, investigations of interest rate expectations generally have used the relationships embodied in the term structure.[2/]

Our purpose is to present new evidence based on a time series of interest rate expectations. The interest rate expectations studied are the median forecast of the weekly average federal funds rate compiled by Money Market Services. To our knowledge, this series has not been examined previously. Following previous research, we first investigate the forecasts' bias and efficiency. We also attempt to find a model of expectations formation that best fits the data.

An interesting aspect of the data arises from the fact that beginning in early 1984, the timing of the survey was changed. This timing change altered the information available to respondents, increasing the relative information set during the more recent period. Thus, of particular interest in the empirical work below is to determine if the change in the timing of the survey influences the outcome of the hypotheses tests.

Section 2 briefly describes the survey data and presents a discussion of the shift in the survey day. Bias test results are reported in Section 3 and efficiency tests are discussed in Section 4. Attempts to ascertain the process by which the forecasts are generated are reported in Section 5. Section 6 closes the paper with a summary of the results.

2. THE DATA

Money Market Services is best known for their weekly survey of 50-60 financial market participants to generate a forecast of the weekly change in M1. In addition to predicting the change in M1, respondents also are asked for other forecasts, one of which is the average level of the federal funds rate for the next statement week.[3/] Although there have been several empirical studies done testing federal funds forecasting models, this study represents the first to examine the survey forecasts of this important financial market variable.[4/]

The median forecast of the weekly average federal funds rate used here was made available for the period from the week ending May 7, 1980 to the week ending February 27, 1985, a total of 252 observations. During this time period, the timing of the survey for the federal funds rate changed. From the beginning of the data set until February 1, 1984, the forecasters were asked on Tuesday to forecast the level of the federal funds rate for the statement week ending Wednesday, eight days hence. For example, the forecast made for the week ending January 4, 1984 was made on December 27, 1983.

With the advent of switching to contemporaneous reserve requirements (CRR), the timing of the survey was changed.[5/] Now Money Market Services conducts a Friday and Tuesday survey, the Tuesday survey being used to allow respondents to update their Friday forecast of the money supply change. The forecast of the federal funds rate, however, is taken only from the Friday poll. Thus, the forecast of the federal funds rate for, say, the week ending June 20, 1984, was taken on the preceding Friday, June 15. Note what effect this change in the survey date has on the information available to respondents. First, the forecast now is made following the most recent announcement of the monetary data. Using our example, the money stock for the week ending June 6 is known to the forecasters. In contrast, under the pre-CRR survey scheme, the money supply for the week ending May 30, one week earlier, would be known. Thus, under the new survey timing, forecasters now have an extra week of data--M1, the adjusted base, borrowing, reserves, etc.--at their disposal relative to the pre-CRR forecast.

The second aspect is that forecasters have additional information on the funds rate level that they are forecasting. This is because the Friday forecast is made two days into the statement week being forecast. Moreover, depending on when the survey is taken, some respondents may have information as to the average value of the rate for Friday and, hence, the rate that will hold for Saturday and Sunday.[6/]

As the foregoing discussion suggests, the change to the Friday forecast day should at least improve the survey's accuracy, because forecasters have increased knowledge of the federal funds rate for the statement week that is forecasted. Indeed, some summary forecasting statistics support this contention. For example, the mean absolute forecast error from the period May 7, 1980 through February 1, 1984 is 0.470. For the period February 8, 1984 through February 27, 1985, it is 0.179. The root-mean-square forecast error from these two samples is, respectively, 0.670 and 0.293. These statistics indicate that median forecast became much more accurate after the change in the forecast day. The questions to which we turn below consider whether this change also influenced the economic characteristics of the forecasts.

3. BIAS TESTS

The survey forecasts of the federal funds rate are unbiased predictors of the actual rate if the actual and predicted values differ by some random term. This can be expressed by the relationship

$$(1) \quad FF_t = {}_{t-1}FF_t^E + \varepsilon_t$$

where FF is the actual level of the federal funds rate in period t, ${}_{t-1}FF^E_t$ is the expectation formed in period t-1 of the rate to hold in period t, and ε_t is a random error term with mean zero and variance σ^2_ε.

To test for unbiasedness, equation 1 is written in the empirical form

$$(2) \quad FF_t = \alpha_0 + \beta_1 \, {}_{t-1}FF^E_t + \varepsilon_t$$

where α_0 and β_1 are parameters to be estimated. To test for unbiasedness, we test the joint condition that $\hat{\alpha}_0 = 0$ and $\hat{\beta}_1 = 1.0$. If this joint hypothesis is rejected, then the forecasts are not unbiased. Moreover, it also should be the case that the error structure does not exhibit serial correlation.

Table 1 presents the results of estimating equation 2 using the actual and survey forecasts of the federal funds rate. Three regression results are presented: one regression for the full period and one for each of the sub-periods delineated by the change in the survey day. The results for the full-period indicate that the estimated constant term is not different from zero at any reliable significance level, and that the β coefficient does not differ from unity (t = 0.17). Even so, the F-statistic on the joint test $\hat{\alpha}_0 = 0$ and $\hat{\beta}_1 = 1.0$ is large enough (1.97) to reject the hypothesis of unbiasedness at the 5 percent level. This finding also occurs for the first subperiod, where the t-statistic testing the hypothesis that $\hat{\beta}_1 = 1$ is only 0.30. The calculated F-statistic, however, is significant at the 2 percent level, rejecting unbiasedness. The results from the full-period and first sub-period are interesting, since even though we cannot reject the individual hypotheses that $\hat{\alpha}_0 = 0$ and $\hat{\beta}_1 = 1.0$, they are rejected jointly. The reason for this outcome stems from the existence of significant serial correlation among the residuals.[7/]

Only for the more recent subperiod can we not reject unbiasedness. The regression results indicate that the individual coefficients meet the requirements, and that there is no evidence of serial correlation. Consequently, the calculated F-statistic for the joint hypothesis is only 0.93. Thus, the results indicate that only during the period after the change in the forecast day do the forecasts satisfy the condition of unbiasedness.

4. EFFICIENCY TESTS

The condition of efficiency necessitates that forecasts reflect pertinent and available information. Two approaches to testing this condition are taken here: First, because the past history of the series being forecast is available to the survey respondents, we may test for weak-form efficiency. In other words, we determine if the survey forecasts efficiently use the information contained in at least the history of the federal funds rate series. The second approach tests whether other sources of information were used efficiently. Generally, this type of test, which may be thought of as a stronger-form efficiency test, is done by determining whether including the information contained in various data series reduces the forecast error. In this paper, we test for this broader efficiency criterion using a framework that allows us to determine the marginal usefulness of information not already included in lagged values of the funds rate.

4a. Tests for Weak-Form Efficiency

This concept of efficiency requires that the process generating the observed federal funds rate series also generates the forecasts. The simplest such process is an autoregressive one, where the actual and expected series are generated only by the past of the series itself. Thus, we have

$$(3) \quad FF_t = \sum_{i=1}^{n} \beta_i \, FF_{t-i} + \mu_{1t}$$

and

$$(4) \quad {}_{t-1}FF_t^E = \sum_{i=1}^{n} \beta_i' \, FF_{t-i} + \mu_{2t}$$

where μ_{1t} and μ_{2t} are random error terms. This form of efficiency testing requires that $\beta_i = \beta_i'$ for all i.

Following Mullineaux [12], a useful test for efficiency combines equations 3 and 4. To determine if the survey forecasts efficiently utilize the information contained in the past history of the funds rate, equation 4 is subtracted from 3 yielding the equation

$$(5) \quad FF_t - {}_{t-1}FF_t^E = \sum_{i=1}^{n} b_i \, FF_{t-i} + \emptyset_t$$

where $b_i = (\beta_i - \beta_i')$ and $\emptyset_t = (\mu_{1t} - \mu_{2t})$. This form of the test requires that the estimated b_i as a group are not statistically different from zero. Moreover, the estimated residuals again should not exhibit significant serial correlation.

Equation 5 is used to test for weak-form efficiency of the federal funds rate forecasts. Prior to estimation the lag length n must be determined. In this paper, we used Akaike's [1] final prediction error

(FPE) criterion. Based on the full period, and allowing for a maximum of 12 lags, the FPE procedure selected a lag of four. Based on this finding, equation 5 was estimated with $n = 4$. The results are presented in table 2.

The full period results indicate that two of the four lags of the federal funds rate are statistically significant. Testing the hypothesis that $b_i = 0$ for all i is rejected easily, given the calculated F-value of 6.89. Moreover, there does not appear to be a significant problem with serial correlation.

The subperiod results, as with the bias test, offer conflicting results. During the first subperiod, the first and third lagged values of the federal funds rate are highly significant, leading to a rejection of the efficiency hypothesis.[8/] In contrast, the estimates from the second period show only the second lag term to be marginally significant at the 5 percent level. More important, at the 5 percent level one cannot reject the hypothesis that the estimated coefficients, as a group, are zero.[9/] This suggests that the hypothesis of weak-form efficiency cannot be rejected for the forecasts taken from the second subperiod, again indicating that the change in the forecast day produced a marked change in the economic characteristics of the forecasts.

4b. Test of Stronger-Form Efficiency

The preceding evidence indicates that during the first subperiod the survey forecasts do not efficiently utilize information available in past federal funds rates. A more stringent form of efficiency requires that the forecasts utilize the pertinent information contained in other relevant data as well. To test for strong-form efficiency, the empirical version of equation 5 is used as the basic specification to which lagged values of other variables are added.

Several variables are suggested in studies that have attempted to build federal funds rate forecasting models (see, for example, Hunt [10]). The variables used in this study consist of changes in the level of M1 ($\Delta M1$), changes in the level of the adjusted monetary base (ΔAB), changes in the level of borrowing from the Federal Reserve (ΔBOR), and a (0, 1) dummy variable to capture changes in the discount rate (DR).[10/] The form of the estimated equation used to test for stronger-form efficiency is

$$(6) \quad FF_t - {}_{t-1}FF_t^E = \sum_{i=1}^{n} \beta_i FF_{t-i} + \sum_{i=1}^{j} \lambda_i \Delta M1_{t-i} + \sum_{i=1}^{k} \emptyset_i \Delta AB_{t-i} + \sum_{i=1}^{m} \delta_i \Delta BOR_{t-i} + \upsilon DR + \varepsilon_t .$$

The test for strong-form efficiency using equation 6 is to determine whether the estimated coefficients for each group of additional variables is significantly different from zero. To do this, equation 6 was estimated allowing four lags on each variable.[11/]

The change in the timing of the survey does not permit us to combine the subperiods. This is because during the first subperiod the change in the money stock is known with an extra week's lag relative to the second subperiod. This increased information availability during the second period also holds true for the adjusted base and borrowing variables. *A priori*, we therefore would anticipate that there is a greater likelihood of rejecting strong-form efficiency during the first subperiod relative to the second.

The F-statistics calculated for each variable, testing the hypothesis that they are zero as a group, are reported in table 3. The results from the first subperiod indicate that, in addition to lagged values of the federal funds rate, only changes in the adjusted monetary base are statistically significant. The other variables, in contrast, do not achieve significance at any reasonable level. Thus, for the first period, lagged levels of the funds rate and changes in the adjusted base statistically lower the survey's forecast errors, suggesting that this available information was not efficiently utilized.

The results from the second subperiod indicate that none of the monetary measures achieve significance at any reliable level. A noticeable change from the outcome in table 2, however, is the increased significance of the lagged values of the actual federal funds rate. This change is due to an increase in the significance of the second lag term on the lagged funds rate (see appendix). Consequently, the test result based on the stronger-form efficiency test provides a mixed outcome with respect to the efficiency of the forecasts during the second subperiod.

5. FORMATION OF EXPECTATIONS

It is useful to examine the survey forecasts to determine the importance placed on past values of the actual federal funds rate and previous forecast errors. This especially may be true given the change in the timing of the survey. Expectations generally are classified as being formed by an adaptive process, whereby forecasters fractionally adjust their current forecast to past forecast errors, or an extrapolative process, where past trends in the forecasted variable are expected to continue or be reversed. If the forecast is based only on last period's actual value, then forecasts are formed statically.

In a recent paper, Pearce [13] provides a useful framework in which the different expectations formation processes are subsumed as special cases. Such a model can be written as

$$(7) \quad {}_{t-1}FF_t^E = \beta_0 + \sum_{i=1}^{N} \beta_i \; {}_{t-i-1}FF_{t-i}^E \; .$$

$$+ \sum_{i=1}^{K} \lambda_i \, FF_{t-i} + \varepsilon_t$$

Various lag combinations were tested in implementing equation 7. Based on the full period outcome, the final model included only one lag of the survey forecast and two lags on the actual federal funds rate. The results of using this model for the different time periods are reported in table 4.12/ The full period and the first sub-period results indicate that the current forecast of the funds rate is influenced significantly by past forecasts and actual values of the funds rate. As shown in the lower panel of table 4, however, the calculated F-statistics do not allow us to reject any of the alternative models.

The results from the second subperiod yield some different outcomes. During the period, the only significant coefficients are the lagged values of the actual funds rate. More important, the relevant test statistics reported in the lower panel indicate that we can reject the restrictions imposed by the static model at reasonably high levels of significance. With regard to discriminating between the extrapolative and adaptive models, however, the test results are inconclusive.

As a further test, it is possible to model the forecasts as a function of both adaptive and extrapolative processes. As Pearce [13] has suggested, such a model could take the form

$$(8) \quad {}_{t-1}FF_t^E = {}_{t-2}FF_{t-1}^E + \beta_1 (FF_{t-1} - {}_{t-2}FF_{t-1}^E) + \beta_2 (FF_{t-1} - FF_{t-2}) + u_t$$

where the coefficient β_1 captures the adaptive adjustment weight and β_2 the extrapolative weight.

Equation 8 was estimated for each sample period. To conserve space, suffice it to say that in the full period and first subperiod, both β_1 and β_2 were found to be significantly different from zero the 5 percent level.13/ The results for the second subperiod, however, suggest that the adaptive coefficient is highly significant and not statistically different from unity ($t = 0.18$). The regression result for this period is (absolute value of t-statistics in parentheses):

$$(9) \quad {}_{t-1}FF_t^E = {}_{t-2}FF_{t-1}^E + \underset{(5.87)}{0.970} (FF_{t-1} - {}_{t-2}FF_{t-1}^E) - \underset{(1.89)}{0.240} (FF_{t-1} - FF_{t-2}) + \underset{(0.45)}{0.015}$$

$$\bar{R}^2 = 0.45 \qquad SE = 0.244 \qquad DW = 2.06$$

Based on equation 9, it again appears that the change in the survey timing has altered the characteristics of the survey forecasts. Although the data cannot differentiate between alternative expectations formation hypotheses during the first subperiod, there is some evidence that during the more recent subperiod forecasts are formed adaptively.

6. SUMMARY

Our purpose in this paper was to examine the characteristics of a survey forecast of interest rates. This series of expectations, the median forecast of the weekly federal funds rate, is compiled by Money Market Services. To our knowledge, a study of this kind has not been reported on this important set of expectations data. An aspect of this data lends itself to testing for changes in unbiasedness and efficiency; namely, since early 1984 the forecasters have had available more timely information upon which to base their expectation. Does such a change in the information available to forecasters affect the outcome of such hypothesis tests?

Our results reveal that increasing the available information set yields to forecasts that are unbiased and weak-form efficient. Although there is some mixed evidence on this latter point, the data also suggest that the more recent forecasts pass the criterion of stronger-form efficiency. In general, then, the evidence indicates that the change in the survey day has altered the economic characteristics of the expectations series. We also attempted to determine the best model of expectations formation. Although the data did not reject several models, there is some evidence that more recent forecasts are formed adaptively.

FOOTNOTES

1/ These survey measures often are referred to as a "market's" expectation. Because the surveys do not poll all market participants and because responding to the survey questionnaire entails no possible economic loss, such a use must be viewed with some skepticism. In this paper, the survey generated forecasts are regarded only as the average forecast from a group of professional market participants.

2/ As noted by Friedman [5], such studies generally have attempted to calculate expectations of interest rates by comparing comparable securities of different maturities.

3/ Survey participants also are asked, at different times, to forecast inflation, unemployment, industrial production, borrowings and several other economic measures.

4/ Studies of the federal funds market and the determination of the observed rate include Boughton [2], Eisemann and Timme [4] and Hunt [10].

5/ The change from lagged reserve requirements (LRR) to CRR involved doubling the reserve maintenance period--the period during which average reserves must equal or exceed required reserves--to two-week periods ending every other Wednesday. In addition, the date of release for monetary data was changed from Friday to Thursday. For a discussion of CRR, see Gilbert and Trebing [6].

6/ The rate forecasted is for the statement week, a seven day average. Because no trading takes place on weekends, the value for Friday is used also for Saturday and Sunday in calculating the average.

7/ The approximate value of the lower critical value for the Durbin-Watson test statistic is 1.80. The DW values in table 1 are well below this value, indicating positive serial correlation.

Although serially uncorrelated errors are a condition of unbiasedness, it may be argued that its existence is more indicative of inefficient forecasts rather than biased ones. This is because serial correlation implies that there is information in the lagged error term that is not being used. Moreover, significant serial correlation biases the estimated standard errors and therefore affects hypothesis testing. Thus, to more fully explore this finding, the full period and first subperiod equations were re-estimated using the Cochrane-Orcutt procedure. Based on the rho-adjusted data, we cannot reject the joint hypothesis for either regression: in both instances the calculated F-statistic is below the 5 percent critical value of 3.04. Moreover, the Durbin-Watson statistics indicate that the problem of serial correlation has been corrected. Thus, the evidence using the adjusted equations suggest that the forecasts are unbiased. Based on a strict interpretation of the conditions necessary for unbiasedness, however, these results are informative to the extent that they reveal how sensitive such tests can be to the existence of serially correlated errors.

8/ Because of the survey's timing during the first period, it may be argued that beginning the information set with the first-lag of the federal funds rate imparts too much information to the survey respondents. In other words, they may know what FF_{t-1} is to a large extent, thus influencing the weak-form efficiency test result. To see if slightly altering the information set changes the results, we tested for weak-form efficiency using lags on the federal funds rate from t-2 through t-5. This alternative regression produced statistically significant coefficients on lags t-2, t-3 and t-5. More important, the calculated

F-statistic testing the hypothesis that $b_i = 0$ for all i was 6.51, easily rejecting the null hypothesis of efficiency.

9/ It should be noted, however, that the calculated F-statistic of 1.91 is significant at the 10 percent level.

10/ Clearly there are other variables that one may experiment with. For our purpose, we sought to use those measures suggested by previous research and those suggested as important factors by market participants.

11/ The FPE criterion was not used in this instance, due to the large number of variables. Based on the actual estimates, reported in the appendix, it does not appear that the use of four lags truncated any longer, significant lag structures.

12/ Because lags of the expectations variable were used to determine the appropriate model, the sample period tested is changed slightly. The sample period begins with the week ending June 4, 1980, rather than with the week ending May 7, 1980.

13/ The results for the full sample are:

$$ {}_{t-1}FF^E_t = {}_{t-2}FF^E_{t-1} + \underset{(8.03)}{0.473}\,(FF_{t-1} - {}_{t-2}FF^E_{t-1}) + \underset{(3.72)}{0.215}\,(FF_{t-1} - FF_{t-2}) \underset{(2.34)}{- 0.058} $$

$\bar{R}^2 = 0.504 \quad SE = 0.375 \quad DW = 2.06$

and for the first subperiod, are:

$$ {}_{t-1}FF^E_t = {}_{t-2}FF^E_{t-1} + \underset{(6.90)}{0.454}\,(FF_{t-1} - {}_{t-2}FF^E_{t-1}) + \underset{(3.77)}{0.246}\,(FF_{t-1} - FF_{t-2}) \underset{(2.40)}{- 0.073} $$

$\bar{R}^2 = 0.524 \quad SE = 0.400 \quad DW = 2.02$

Table 1
Bias Test Results

Sample Period[1/]	Estimated coefficients[2/]		Summary Statistics[3/]			
	α_0	β_1	F	DW	$\bar{R}^2$	SE
5/7/80-2/27/85	0.072 (0.51)	1.002 (85.78)	2.97 (0.05)	1.42	0.967	0.602
5/7/80-2/1/84	0.180 (1.03)	0.996 (73.36)	3.82 (0.02)	1.39	0.965	0.661
2/8/84-2/27/85	0.300 (0.85)	0.966 (27.59)	0.930 (0.40)	2.12	0.933	0.294

Notes: 1/ Sample period for weeks ending dates shown.

2/ t-statistics listed in parentheses.

3/ The reported F-statistic is based on the joint test $\hat{\alpha}_0 = 0$; $\hat{\beta}_1 = 1$. The marginal significance level is reported in parentheses. DW is the Durbin-Watson test statistic; $\bar{R}^2$ is the adjusted coefficient of determination; and SE is the regression standard error.

Table 2
Weak-Form Efficiency Test Results

Sample Period[1/]	Estimated Coefficients[2/]					Summary Statistics[3/]			
	Constant	β_1	β_2	β_3	β_4	F	$\bar{R}^2$	SE	DW
5/7/80-2/27/84	0.073 (0.53)	0.161 (2.73)	0.078 (0.93)	-0.231 (2.75)	-0.005 (0.09)	6.89*	0.08	0.575	1.75
5/7/80-2/1/84	0.190 (1.13)	0.173 (2.56)	0.056 (0.58)	-0.221 (2.27)	-0.012 (0.18)	5.71*	0.09	0.629	1.77
2/8/84-2/27/85	0.430 (1.16)	-0.028 (0.26)	0.265 (2.01)	-0.236 (1.78)	-0.047 (0.42)	1.91	0.06	0.284	2.08

Notes: 1/ Sample period for weeks ending dates shown.

2/ Absolute value of t-statistics in parentheses.

3/ F-statistic to test H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$. An (*) denotes significance at 5 percent level. $\bar{R}^2$ is the coefficient of determination adjusted for degrees of freedom; SE is the regression standard error; and DW is the Durbin-Watson test statistic.

Table 3
Strong-Form Efficiency Test Results

Sample Period[1/]	F-statistics (significance level)[2/]				
	FF	DR	ΔM1	ΔAB	ΔBOR
5/7/80-2/1/84	6.05 (0.00)	0.17 (0.68)	1.42 (0.23)	5.44 (0.00)	1.67 (0.16)
2/8/84-2/27/85	2.77 (0.04)	0.07 (0.80)	0.97 (0.44)	1.01 (0.42)	1.15 (0.35)

Notes: 1/ Sample period for weeks ending dates shown.

2/ FF is the actual federal funds rate; DR is the discount rate change dummy; ΔM1 is the change in the level of M1; ΔAB is the change in the level of the adjusted monetary base; and ΔBOR is the change in the level of borrowing from the Federal Reserve System.

Table 4
Tests of Expectations Formation

Equation Estimated: $_{t-1}FF_t^E = \beta_0 + \beta_1\ {}_{t-2}FF_{t-1}^E + \lambda_1 FF_{t-1} + \lambda_2 FF_{t-2} + \varepsilon_t$

Sample Period[1/]	Estimated Coefficients[2/] β_0	β_1	λ_1	λ_2	Summary Statistics[3/] $\bar{R}^2$	SE	Dh
6/4/80-2/27/85	0.084 (0.94)	0.510 (8.55)	0.687 (15.84)	-0.209 (3.62)	0.987	0.374	0.92
6/4/80-2/1/84	0.045 (0.42)	0.535 (8.06)	0.699 (14.46)	-0.244 (3.73)	0.987	0.400	-0.27
2/8/84-2/27/85	-0.069 (0.22)	0.028 (0.17)	0.734 (6.44)	0.246 (1.89)	0.953	0.246	NA

Restrictions:[4/]	F-statistics (significance levels) 6/4/80-2/27/85	6/4/80-2/1/84	2/8/84-2/27/85
1) $\beta_1 = \beta_3 = 0$; $\beta_2 = 1$	33.16 (0.00)	27.07 (0.00)	2.96 (0.04)
2) $\beta_0 = \beta_1 = \beta_3 = 0$; $\beta_2 = 1$	30.87 (0.00)	27.62 (0.00)	2.31 (0.07)
3) $\beta_0 = \beta_1 = 0$	38.16 (0.00)	32.71 (0.00)	0.04 (0.96)
4) $\beta_1 + \beta_2 = 1$; $\beta_3 = 0$	8.32 (0.00)	7.80 (0.00)	1.80 (0.18)
5) $\beta_0 = \beta_3 = 0$; $\beta_1 + \beta_2 = 1$	8.91 (0.00)	9.13 (0.00)	1.23 (0.31)

Notes: 1/ Sample period for week ending dates shown.

2/ Absolute value of t-statistics in parentheses.

3/ $\bar{R}^2$ is the coefficient of determination adjusted for degrees of freedom; SE is the regression standard error; and Dh is the Durbin h-statistic. The Dh could not be calculated for the second subperiod. The Durbin-Watson statistic for this regression is 2.07.

4/ The expectations models corresponding to the restrictions test are: 1) static with trend; 2) static without trend; 3) extrapolative without trend; 4) adaptive with trend; and 5) adaptive without trend.

APPENDIX A
Stong-Form Efficiency Test Regressions
(Absolute Value of t-statistics in parentheses)

	Sample Period	
Variable	5/7/80-2/1/84	2/8/84-2/27/84
Constant	-0.274 (1.16)	1.004 (2.03)
FF_{t-1}	0.216 (3.08)	-0.078 (0.51)
FF_{t-2}	-0.036 (0.34)	0.374 (2.14)
FF_{t-3}	-0.044 (0.40)	-0.241 (1.55)
FF_{t-4}	-0.121 (1.64)	-0.153 (1.03)
$\Delta M1_{t-1}$	-0.026 (1.46)	0.011 (0.69)
$\Delta M1_{t-2}$	0.004 (0.18)	0.001 (0.09)
$\Delta M1_{t-3}$	-0.028 (1.32)	-0.028 (1.57)
$\Delta M1_{t-4}$	-0.029 (1.45)	-0.017 (0.98)
ΔAB_{t-1}	0.350 (2.98)	-0.014 (0.47)
ΔAB_{t-2}	0.293 (2.36)	-0.056 (1.78)
ΔAB_{t-3}	0.466 (3.72)	-0.022 (0.71)
ΔAB_{t-4}	0.021 (0.19)	-0.025 (0.84)
ΔBOR_{t-1}	-0.239 (1.85)	-0.009 (0.16)
ΔBOR_{t-2}	-0.054 (0.37)	0.004 (0.08)
ΔBOR_{t-3}	-0.243 (1.79)	0.092 (1.63)
ΔBOR_{t-4}	0.001 (0.01)	0.104 (1.74)
DR	-0.065 (0.41)	0.046 (0.26)
$\bar{R}^2$	0.208	0.108
SE	0.586	0.277
DW	1.75	2.28

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